Non-insect Arthropoda (Isopoda, Arachnida and Myriapoda) on the high mountains of tropical Africa

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Abstract: For the first time an overview is given of the distribution of non-insect arthropods (Isopoda, Arachnida and Myriapoda, or IAM) of the montane zone of tropical Africa: Mt Cameroon, Mt Kenya, Kilimanjaro, Ruwenzori, Mt Elgon, Mt Meru and some Ethiopian mountains including Semien. Although "montane" is usually defined as the area above the forest, here we arbitrarily indicate two lines above which the fauna is analyzed: 2200 m (allowing comparison with the Eurasian oreal) and 3500 m, above which throughout the world lower atmospheric pressure, higher UV radiation and the same ecological factors are present. We present the montane fauna of Isopoda, Arachnida and Myriapoda of the Afrotropical oreal and compare it with the fauna of those zones in the northern regions of the Old World, e.g. Europe, Himalaya and Central Asia.

We list in the appendixall species of IAM found in Africa above 3500 m and thus give a complete list of all hypsobionts so far described.

In Africa, we found IAM up to 4600 m (Isopoda), 2600 m (Schizomida), 3500 m (Scorpionida), 4100 m (Pseudoscorpionida), 4600 m (Opilionida), 4930 m (Araneida), 4590 m (Acari), 4500 m (Symphyla), 4500 m (Chilopoda), and 4200 m (Diplopoda). The level of endemism is low and, at least concerning the IAM, the Afrotropical montane fauna does not form a separate zoogeographical unit. Comparisons between the IAM of the Afrotropical oreal and the oreals of Europe, Central Asia and the Himalaya present a very diversified pattern. This phenomenon is discussed under evolutionary aspects.

Key words: Afrotropical oreal, Isopoda, Arachnida, Diplopoda, Chilopoda, Symphyla, biodiversity

Introduction

While there are several important studies on the ecology of the insect life at high altitude (especially by Mani 1968, centred on the Himalayan fauna), no attempt is known concerning such important groups as the non-insect arthropods (essentially Isopoda: Oniscidea, Arachnida and Myriapoda). Most of the recent contributions to these groups are based on the rich collections of J. Martens and other zoologists from the Himalaya. But the high mountains of Africa have also been investigated by many expeditions and we can now put together the available information and try to come to some conclusions.

For several decades the author has explored high mountains in all continents and so has had the chance to get a personal impression of the high mountain environment, as well as to collect important series of Isopoda, Arachnida and Myriapoda, most of which are still under study. This research also included tropical West, Central and East Africa (the mountains of Cameroon, the Ruwenzori, Kilimanjaro and Mt Elgon).

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Here under "high mountains of East and Central Africa" we understand the mountains north of the Zambezi, east of 30°E and south of Egypt. In this area the highest mountains in Africa are situated: the volcanos Kilimanjaro (5895 m), Mt Kenya (5199 m), Mt Meru (4567 m), Karisimbi (4507 m), Mt Elgon (4322 m), and the massif of Ruwenzori (5109 m). Some other high mountains in this area are: in Tanzania: Uluguru (2653 m), Ngorongoro (Lulmalasin 3648 m, Oldeani 3188 m), Usumbura (2570 m), Pare (2463 m), Kipengere (Mtorwi 2961 m), and Rukwa (Tapepo 2694 m); in Kenya: Aberdare (Satima 3963 m, Kinangop 3960 m); and in Malawi: Sapitva (3000 m). Aberdare is only 100 km distant from Nairobi and is therefore well explored. Mt Elgon has also been visited by collectors of ground fauna. Larger collections of IAM exist only from Kilimanjaro, Mt Kenya, Mt Meru, Mt Elgon, Ruwenzori, and Aberdare (see fig.1).

The mountains of Ethiopia are much less explored, but are very interesting from a zoological point of view. The highest tops are situated in the Semien massif (Ras Dashan 4623 m), followed by Mandebo (4310 m in the Bale National Park), Guna (4231 m), Guge (4203 m), Kakka (4193 m), Abune Josef (4193 m), and Mangestu (Tala 4100 m). The Semien mountains were glaciated up to 2600 m. Fako (height 4090 m) is the highest summit of the volcano range on the border between West and Central Africa.

The zone with forest or higher scrub vegetation in the mountains ascends according to temperature and precipitation. At an altitude of 2200 m a.s.l. on every mountain in tropical Africa we find forest or a man-made landscape. But everywhere at 3500 m a.s.l. we find the conditions typical of the montane environment: lower atmospheric pressure, higher UV radiation and a vegetation adapted to these conditions. We present here the Isopoda, Arachnida and Myriapoda[1] fauna reaching or surpassing 2200 m to have the basis for a comparison with similar montane regions of the Old World. And we present the IAM fauna for 3500 m, the zone where the fauna consists of true hypsobionts.

In the following paragraphs we will give some general information on the distribution of IAM in the Old World (Africa plus Eurasia), with special reference to the montane regions of Europe, the Himalaya and Central Asia. Data on IAM in Africa are given here only if this is essential for the general overview. But every zoologist who is not specialized in IAM will have problems understanding the system of these non-insect athropods; this is especially true because the endings of classes, orders or suborders are often not self-explanatory (s. table 1).

Isopoda. In contrast to the high diversity of montane woodlice in Africa, the number of families, genera and species in the oreals of the rest of the Old World is rather poor. In the oreals of Europe and Asia there are no endemic families. The number of genera is much smaller and none is endemic. Out of 23 species known in the Old World occurring higher than 3500 m, 12 live in East and Central Africa.

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[1]) Myriapoda is used here as a superclass, including the classes Symphyla, Pauropoda, Chilopoda and Diplopoda; we know that Myriapoda possibly is not a real taxon, but a polyphylum.

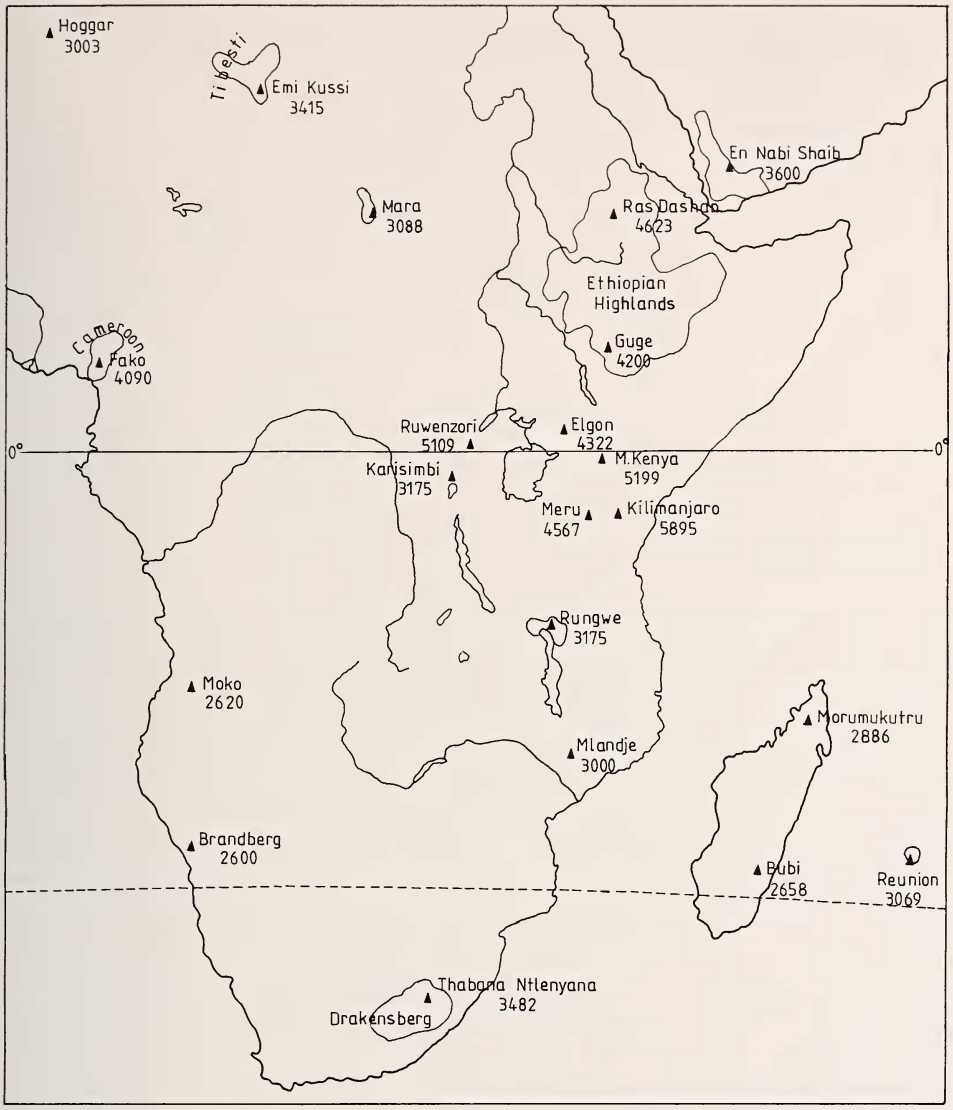

Fig.1: Map of Central and South Africa, showing the main elevations.

Arachnida. All 8 orders of Arachnida are known from the high mountains of the Old World and most from high altitudes in Africa (except Solpugida). They are also present in the oreal of the Americas. The orders not represented in the montane fauna of Eurasia and Africa (Palpigradi, Amblypygi, Uropygi, Ricinulei, Opilioacarida), are also absent from the high mountains of the western hemisphere, although these orders do occur there at lower altitudes.

Table 1: The higher taxa of Isopoda, Arachnida and Myriapoda dealt with in this paper (the groups found in tropical Africa above 2200 m are in bold):

Class **Crustacea**
Order **Isopoda**
Suborder **Oniscidea**

Class **Arachnida**
Order **Schizomida**
Order Scorpionida
Order Solpugida
Order **Araneida**
Order **Pseudoscorpionida**
Order **Opilionida**
Suborder **Laniatores**
Suborder **Palpatores**
Order **Acariformes**
Suborder Acaridida
Suborder **Prostigmata**
Suborder **Oribatida**
Order Parasitiformes
Suborder **Gamasida**
Suborder **Ixodida**

Superclass **Myriapoda**
Class **Symphyla**
Class Pauropoda
Class **Chilopoda**
Order **Lithobiomorpha**
Order **Geophilomorpha**
Order **Scolopendromorpha**
Order Scutigeromorpha

Class **Diplopoda**
Order **Polyxenida**
Order Glomerida
Order Craspedosomatida
Order Julida
Order Chordeumatida
Order **Stemmiulida**
Order **Spirostreptida**
Order **Polydesmida**

Scorpionida. Five families in the Old World are known to contain species living over 2200 m. Some genera of Buthidae (*Uroplectes, Lychas*) are known to live up to 3500 m on Mt Meru and at 3000 m on Kilimanjaro. In South America, scorpions live much higher (*Orobothriurus crassimanus* Maury, family Bothriuridae, up to 5560 m in Peru). Polis (1990) writes: "Such high-elevation species are all small. They feed on a diverse array of arthropods that are also found at these heights (Mani 1968), and their small size may be due to the short period during which they are able to forage... 'Cold hardiness' allows at least some species to survive freezing temperatures. Surprisingly, high-altitude scorpions live under rocks, in scrapes, and in relatively short burrows (...), rather than in deep burrows with terminal chambers below the frost line".

Solpugida. At least five of the Old World families contain species living higher than 2200 m. In South America, other families of this order (Ammotrechidae) can reach even 5000 m (*Dasycleobis crinitus* Mello-Leitao in Argentina). The highest record for the Old World is of *Galeodes setulosus* Birula from Tajikistan (4000 m).

Schizomida. These small arachnids are warm-loving and clearly avoid the high mountain environment. The highest record (2600 m) is from Tanzania (Reddell & Cokendolpher 1995).

Pseudoscorpionida. This order shows a high diversity all over the montane regions of the Old World. However table 2 demonstrates that the different families and genera have their typical distribution; none is evenly spread over the four regions.

Table 2: Number of species of different genera and families of Pseudoscorpionida living at or above 2200 m in Europe, Central Asia, Himalaya and tropical Africa

	Europe	Centr. Asia	Himalaya	Africa
Chthoniidae	**3**	**1**	**2**	**2**
Centrochthonius	0	1	0	0
Chthonius	3	0	0	0
Lagynochthonius	0	0	1	0
Tyrannochthonius	0	0	1	2
Lechytiidae	**0**	**0**	**1**	**1**
Lechytia	0	0	1	1
Tridenchthoniidae	**0**	**0**	**1**	**3**
Compsaditha	0	0	0	1
Ditha	0	0	1	0
Pycnodithella	0	0	0	1
Verrucadithella	0	0	0	1
Geogarypidae	**0**	**2**	**2**	**2**
Afrogarypus	0	0	0	2
Geogarypus	0	2	2	0
Olpiidae	**0**	**2**	**1**	**1**
Calocheiridius	0	0	1	1
Garypinus	0	1	0	0
Olpium	0	1	0	0
Hyidae	**0**	**0**	**5**	**0**
Stenohya	0	0	4	0
syn. *Laevigatocreagris*	0	0	1	0
Neobisiidae	**17**	**2**	**2**	**2**
Bisetocreagris	0	2	1	0
Microbisium	0	0	0	1
Neobisium	16	0	0	1
Nepalobisium	0	0	1	0
Roncus	1	0	0	0
Syarinidae	**0**	**0**	**0**	**1**
Ideoblothrus	0	0	0	1

	Europe	Centr. Asia	Himalaya	Africa
Cheiridiidae	**0**	**0**	**2**	**3**
Apocheiridium	0	0	1	1
Cheiridium	0	0	1	0
Cryptocheiridium	0	0	0	2
Atemnidae	**0**	**1**	**2**	**9**
Atemnus	0	1	2	0
Cyclatemnus	0	0	0	4
Micratemnus	0	0	0	1
Paratemnoides	0	0	0	1
Titanatemnus	0	0	0	3
Cheliferidae	**0**	**6**	**3**	**4**
Dactylochelifer	0	5	1	0
Gobichelifer	0	1	0	0
Chelifer	0	0	0	1
Hansenius	0	0	0	1
Hysterochelifer	0	0	1	0
Lophochernes	0	0	1	0
Microchelifer	0	0	0	2
Chernetidae	**1**	4	9	14
Alochernes	1	1	0	0
Caffrowithius	0	0	0	5
Ceriochernes	0	0	3	0
Lasiochernes	0	0	0	1
Dendrochernes	0	1	1	0
Lamprochernes	0	0	1	0
Megachernes	0	1	3	0
Nudochernes	0	0	0	8
Orochernes	0	0	1	0
Pselaphochernes	0	1	0	0
Withiidae	**0**	**0**	**1**	**7**
Ectromachernes	0	0	0	1
Stenowithius	0	0	0	1
Trichotowithius	0	0	0	2
Withius	0	0	1	3

Opilionida. The short-footed Cyphophthalmi do not live above 2000 m. The numerous species and genera belonging to Laniatores are confined mostly to tropical countries, including high mountains. In the mountains of tropical Africa, Laniatores are clearly predominant. In the high mountains of Europe, Laniatores do not live higher than 2000 m.

In the Old World 227 species of harvestmen (84 Laniatores and 143 Palpatores) reach or go higher than 2200 m. Here 11 families are known to exist, but much less

are true high mountain-dwellers and only three families of Laniatores contain true members of high mountain species: Phalangodidae, Biantidae and Assamiidae. The latter two families live also above 4000 m (Biantidae up to 4250 m in Nepal, Assamiidae up to 4600 m on Kilimanjaro). Between 2200 and 4000 m the number of genera and species almost halves every 500 m. Above 4500 m only one species was found: *Hypoxestus accentuatus* Sörensen (Assamiidae) on Kilimanjaro.

Table 3: The nine families of Old World Araneida living above 3500 m (listed according to altitude):

Lycosidae: 70 species up to 6100 m
Salticidae: 85 species up to 5947 m
Linyphiidae: 447 species up to 5545 m
Hahniidae: 14 species up to 5181 m
Gnaphosidae: 74 species up to 4980 m
Dictynidae: 9 species up to 4930 m
Thomisidae: 48 species up to 4880 m
Theridiidae: 24 species up to 4600 m
Araneidae: 23 species up to 4500 m

Araneida. High-altitude spiders belong almost exclusively to the suborder Araneomorphae. The only three species (all African) of the suborder Mygalomorphae are not known from localities higher than 2500 m. Above 3500 m only representatives of Araneomorphae are met. The nine families, reaching or surpassing 4500 m, outline the habitus of the spider fauna in the highest regions of the Old World. They contain 794 of the total of 904 species of spiders living above 2200 m in the Old World (table 3).

Table 4: Number and percentage of species of the family Linyphiidae that reach or surpass different altitudes of the total of Araneida species

	Araneida	Linyphiidae	
altitude	no. of species	no. of genera	no. of species (percentage)
2000 m a.s.l.	904		447 (49,6%)
3000 m a.s.l.	351	57	179 (51%)
4000 m a.s.l.	74	18	37 (50%)
5000 m a.s.l.	10	3	3 (33%)

From these data we can see that the bulk of species living in all high mountains of the Old World belong to the family Linyphiidae (s.lat.).

Clearly none of the genera can be considered to be dominant in the high mountains of the Old World, except *Lepthyphantes* s.lat., which contains 10 % of all high altitude spiders and was recorded up to 5545 m. *Pardosa* and *Xysticus* also have many species widespread in higher altitudes.

Acariformes. All three suborders occur in high mountains. The present maximum recorded altitude is 6100 m (in Nepal). – Acaridida are not well studied.

Prostigmata are represented at altitudes above 2200 m in the Old World by not less than 256 species in 95 genera and 31 families (a tiny fraction of the

prostigmatic mites known in the world with more than 14 000 species in 140 families and 1100 genera). The most species-rich are the families of Trombiculidae (53), Trombidiidae (41), Erythraeidae (38), Bdellidae (18) and Rhagidiidae (18). The genus *Balaustium* (Erythraeidae) contains the most species (19). The families of the Prostigmata are cosmopolitan. Seventeen of them reach 3000 m, 11 (with 23 genera and 35 species) 3500 m, seven 4000 m, four 4500 m, and one 5000 m. None of all identified prostigmatic mites was recorded up to 6100 m. The highest records are of Adamystidae (5100 m in the Hindu Kush), Anystidae (4950 m in Nepal), Rhagidiidae (4800 m on Kilimanjaro), Pygmephoridae (4500 m in New Guinea), Erythraeidae (4260 m in New Guinea), Trombidiidae (4200 m on Ruwenzori), Trombiculidae (4155 m in Pakistan). With more intense research the upper limit of Bdellidae and other families most probably will rise. The bulk of the material so far collected remains unidentified due to the lack of specialists.

Oribatida. Among the montane Acariformes, the soil-inhabiting species of the suborder Oribatida are most numerous. With their 66 families found at or above 2200 m, the Oribatids are the most diversified suborder of all high-altitude Arthropods, even more varied than the spiders. In the whole world more than 7000 oribatid mites have been described, belonging to 177 families. Their importance in natural ecosystems is enormous (in some places more than 70 % of all soil mites). Together with the theoretical interest they represent, this has led to an intensive research of the group by many specialists. The families Oppiidae (36), Ceratozetidae (33), and Phthiracaridae (18) contain most species. With increasing altitude the number of families and species decreases (table 5).

Table 5: Decrease of Oribatida (families and species in the Old World) with increasing altitude

> 2200 m: 66 families, 328 species
> 3000 m: 41 families, 116 species
> 3500 m: 31 families, 70 species
> 4000 m: 19 families, 28 species
> 4500 m: 16 families, 19 species
> 5000 m: 13 families, 15 species
> 5500 m: 9 families, 11 species

Oribatida have been recorded in the Himalaya as high as 6100 m (Janetschek 1990). This author found in Nepal at up to 5800 m representatives of the families Brachychthoniidae, Hermanniidae, Damaeidae, Ceratoppiidae, Tectocepheidae, Suctobelbidae, Oribatulidae, Ceratozetidae and at up to 5500 m Oribatellidae, which are not yet identified to species level. Certainly at 5000 m tens of species live which are at the base of the scarce nival biota.

Parasitiformes. All three suborders in this order are known from high mountains of the Old World. The Gamasida form the bulk of representatives of the order Parasitiformes, but they are as yet poorly studied, except the fauna of the Alps. Several species (mostly parasites and commensals on mammals) have been recorded from only a few places (Hindu Kush up to 4550 m, Kilimanjaro up to 4285 m). Members of at least eight families live higher than 3000 m: Parasitidae, Macrochelidae, Halolaelapidae, Zerconidae, Rhodacaridae, Hypoaspididae, Dermanyssidae, Laelapidae. Two of the three families of the suborder Ixodida are known from the montane environment (parasites on birds and mammals). Thanks to intensive research of the Himalayan fauna between 1960 and 1980 mainly by H.

Hoogstraal and his colleagues, Argasidae have been found up to 4575 m in Nepal and Ixodidae as high as 5488 m. *Ixodes berlesei* (on the Snow Partridge *Lerwa lerwa* in Nepal at 5488 m) is the highest representative of the Parasitiformes ever found.

Symphyla. With about 160 species this is a small class. Both of its families (Scolopendrellidae and Scutigerellidae) live in all high mountain regions of the world and are represented in this environment with a total of 25 species. The genus *Hanseniella* prevails in the tropical mountains and is practically the only genus of Symphyla known to live in the mountains above 3000 m.

Chilopoda. The centipedes contain about 2800 known species of which at least 80 live in the Old World above 2200 m.

Identified species of Geophilomorpha in the Old World are known up to 3600 m (*Tygarrup nepalensis* Shinohara, Mecistocephalidae, Nepal), but Janetschek (1990) has collected Geophilidae in Nepal even at 4400 m. Our observations confirm the occurrence of Geophilomorpha at high altitudes. The genus *Schendylurus* has been recorded in Peru slightly higher (4500 m).

Scolopendromorpha reach 4000 m on Mt Elgon (*Scolopendra afra* Mein.), 4500 m in Nepal (*Cryptops doriae* Pocock) and 4150 m in the Andes.

The representatives of Lithobiomorpha (Lithobiidae) reach the highest altitude of all Myriapoda (up to 5700 m in the Himalaya). They are the most numerous within the four classes of Myriapoda and one of the most conspicuous arthropods in the high mountains of Eurasia. Only one other family of Lithobiomorpha has been recorded from considerable altitudes – two species of the genus *Lamyctes* (Henicopidae) reach 4000 m, one occurs above 4000 m in the mountains of tropical Africa.

Scutigeromorpha reach 4250 m in Nepal (our unidentified collections); they are not recorded from high altitudes in Africa.

Diplopoda. Out of the total of 16 orders in the class Diplopoda, 12 include species that are found above 2200 m in the Old World. As far as we know, in the orders Glomeridesmida, Platydesmida, Spirobolida and Siphoniulida no species are found at that altitude. Out of more than 12 000 species of Diplopoda described in the world, at least 237 have been recorded in the Old World from altitudes higher than 2200 m, including 20 from the mountains of tropical Africa.

Material and method

We summarized the available information from the literature on the species of Isopoda, Arachnida and Myriapoda in Africa living higher than 2200 m. This dataset was completed by data obtained by our own collecting in the mountains of tropical Africa:

– in December 1977 from Buea to the top of Fako, the summit (4090 m) of Mount Cameroon, and on the island of Bioko (formerly Fernando Poo) on the slopes of Pic de Malabo (3008 m)

– in 1983 on Kilimanjaro in Tanzania

– in 1993 on Ruwenzori in Uganda and Mt Elgon in Kenya.

We also collected on many European mountains, in the Karakorum, Himalaya and other mountains in Asia. Here, too, the available information in the literature was gathered. When comparing of the oreals of Africa, Europe, Himalaya and Central Asia, special attention was paid to the distribution of IAM in different altitudinal belts. Parts of the collected material is still under study and therefore does not appear in the lists and in the different comparisons.

Within the accounts there is some help for the reader: classes and orders, when they are named for the first time, are in bold and suborders are underlined.

Isopoda, Arachnida and Myriapoda in the mountains of tropical Central and East Africa

When we here describe the IAM from the montane Afrotropis so far identified, some aspects should be kept in mind: a great number of species, genera, families, or orders are known from lowland Africa. In most cases we do not point out that the taxon may occur elsewhere in Africa but that it is absent from the tropical mountains. The conclusions about endemism would change considerably if we were to include lowland taxa.

Isopoda

The essential information on the woodlice of the mountains of East Africa comes from the collections of the Swedish Expedition of Y. Sjöstedt in 1905-1906 (identified by Budde-Lund), from the material collected by R. Jeannel and the other participants to the Omo Expedition (identified by L. Paulian de Félice), from the collection of H. Franz (published by K. Schmölzer), and from the results of the Zoological Mission in East Africa of IRSAK (P. Basilewsky and N. Leleup), the material having studied by F. Ferrara and S. Taiti. Data on the terrestrial Isopoda of the high mountains of Ethiopia can be found in the paper by Barnard (1940), who identified the material collected by J. Omer-Cooper in 1926-27, as well as in the interesting note by A. Vandel in the general paper by Scott (1958). The species of the well-explored East and Central African mountains (Ruwenzori, Mt Elgon, Mt Kenya, Kilimanjaro, Aberdare, Uluguru, etc.) are well known, whereas we have little information about Ethiopia and Malaw, and the fauna of Mt Cameroon above 3000 m is still unexplored. Considerable material, presently being identified in Florence, was also collected by us on the mountains of Kilimanjaro, Mt Elgon and Ruwenzori.

At the moment we know that 66 species of Isopoda in Afrotropical mountains reach or surpass 2200 m: Mt Elgon 9 species, Kilimanjaro 12, Mt Meru 11, Ruwenzori 3, Nyiragongo 2, Aberdare 6, Kivu 1, Uluguru 7, Mt Kenya 4, Ethiopia 4, Malawi 6, Mt Fako 1. At least 42 species live above 2500 m, 23 above 3000 m, 11 above 3500 m and 5 at or above 4000 m.

In the East and Central African mountains above 2200 m there are at least 49 species belonging to 27 genera and five families. These are: Philosciidae (*Afrophiloscia, Uluguroscia, Arcangeloscia, Pleopodoscia, Buddelundiscus*), Porcellionidae (*Thermocellio, Uramba, "Porcellio"*), Oniscidae (*Alloniscus*), Eubelidae (*Eubelum, Gelsana, Gerutha, Rufuta, Periscyphops, Stegosauroniscus, Benechinus, Kenyoniscus, Periscyphis, Mesarmadillo, Hiallum, Hiallelgon,*

Arthiopopactes, Oropactes, Microcercus) and Armadillidae (*Pseudodiploexochus, Ctenorillo, "Synarmadillo"*). Twelve genera in four families (Eubelidae 9, Philosciidae 1, Porcellionidae 1, and Armadillidae 1) reach or surpass 3500 m.

The tropical family Eubelidae contains the highest number of genera and species living in high mountains. Eighteen genera contain species that live above 2200 m. The highest living are *Aethiopopactes* Verh (*Ae. chenzemae*) (4600 m on Kilimanjaro) and *Benechinus* Budde-Lund (*B. armatus*) (4600 m on Mt Meru), but also in the genera *Eubelum, Hiallelgon, Hiallum, Mesarmadillo, Periscyphis,* and *Microcercus* there are species recorded from altitudes at or over 3500 m.

Genera of Isopoda endemic to the Afrotropical mountains are *Benechinus, Gerutha, Hiallelgon, Hiallum, Kenyoniscus, Stegosauroniscus,* (Eubelidae), and *Ctenorillo* (Armadillidae). High altitude endemics are *Benechinus* (only on Meru and Kilimandjaro, 2200-4600 m), *Stegosauroniscus* (Meru, 2200-2600 m, Kilimandjaro, 2200 m) and others.

All 66 Isopoda species from Afrotropical mountains above 2200 m are endemics. Most species obviously occur only on one massif. Species that were collected from two mountain massifs are: *Afrophiloscia uncinata*, *Stegosauroniscus horridus*, *Benechinus armatus* (Kilimanjaro and Meru, which are close together but nevertheless separated by savanna) and *Oropactes maculatus* (Uluguru and mountains in Malawi).

Arachnida

Scorpionida. Some genera of the family Buthidae (*Uroplectes, Lychas*) are known to live at up to 3500 m on Mt Meru and at 3000 m on Kilimanjaro.

Solpugida. Although this order is well represented in Africa, none of its many species is known to live in this continent higher than 2200 m (lack of research?).

Schizomida. These small Arachnids are warm-loving and clearly avoid the high mountain environment. They have been found at up to 2600 m in Tanzania (Reddell & Cokendolpher 1995). Since at this altitude we find the usual vegetation cover we think that Schizomida are not a part of the hypsobionts of Africa.

Pseudoscorpionida. The studies of Tullgren, Beier, Mahnert, Redikorzev and our own collecting in Kenya, Tanzania and Uganda have shown that 56 species (in 25 genera and 13 families) live at or above 2200 m in East and Central African mountains; 22 reach 3000 m, six 3500 m and one is known to live above 4000 m.

Of the 56 species above 2200 m, almost all are endemic to the mountains of the Afrotropis (see footnote p. 166), but there are almost no endemic genera: *Trichotowithius* (Withiidae) is known only from two high-mountain species (above 2100 m), one in Ethiopia another on Mt Elgon. Most of the remaining genera are widespread in Africa, some of them even outside the continent.

Besides the two species of *Trichotowithius*, we can consider as hypsobionts four species of the genus *Nudochernes* (*N. nidicola* 2470-3000 m, *N. montanus* 3500 m, *N. crassus* 3000-3700 m, and *N. granulosus* 2600 m) inhabiting the nests of *Tachyoryctes* (Rodentia, Rhizomyidae), as well as *Tyrannochthonius brevimanus* (2280-3300 m), *Lechytia maxima* (2350-2650 m), *Cryptocheiridium elgonense* (2650-3200 m), and *Titanatemnus palmquisti* (2000-4100 m), all from the well researched Mt Elgon, can be considered as endemics. *T. palmquisti* is found also on

Kilimanjaro and Mt Meru, raising again the question of how the "island" fauna of the Afrotropical mountains (spiders, Chilopods and other groups) might have developed.

Opilionida. Knowledge of the rich montane Afrotropical fauna (at least 66 species living above 2200 m) comes from the studies of Sörensen (1910), Goodnight & Goodnight (1959), Roewer (1913, 1941, 1956), Lawrence (1962), and Kauri (1985). The short footed Cyphophthalmi do not live above 2000 m. The numerous species and genera of the Laniatores are confined mostly to tropical countries, including high in the mountains where they are strikingly predominant. Of the Palpatores, predominant in the Palaearctic Region, in the Afrotropical oreal we find only the largest family, Phalangiidae, which contains the bulk of the high altitude opilions, i.e. more than half of all genera and species known within the order ocurring above 2200 m.

Among the 66 species of opilionids (46 from Laniatores and 20 from Palpatores, 11 and 6 genera respectively; both relations close to 2:1) recorded above 2200 m (on Kilimanjaro, Mt Kenya, Mt Meru, Mt Elgon, Aberdare, Uluguru, Oldeani, Ruwenzori, Hanang, and Semien), 34 species were found above 3000 m, 26 above 3500 m, 12 above 4000 m, and only two (*Hypoxestus accentuatus*, Assamiidae, and *Rhampsinitus bettoni*, Phalangiidae) above 4500 m.

For an understanding of the sources of the Opilionida fauna of the high mountains of East and Central Africa table 6 may be useful.

Table 6: Distribution of the two suborders of Opilionida in Africa (after Lawrence 1962)

	Laniatores		Palpatores	
Area	**Phalangodidae**	**Assamiidae**	**Triaenonychidae**	**Phalangiidae**
East Africa	numerous	dominant	absent	numerous
Central Africa (Congo Area)	numerous	dominant	absent	absent
Madagascar	numerous	absent	dominant	absent
Southern Africa	rather numerous	absent	dominant	numerous

In the Afrotropical oreal at least 20 genera have been recorded, most of them from the Assamiidae (11 or 55 %), and six from the Phalangiidae (30%).

The endemic genera of Afromontane opilions living between 2200 and 3500 m (usually for several mountains) are : *Monobiantes* (2200 m), Proconomma (2400 m), *Abdereca* (3100 m), *Bambereca* (2900 m), *Erecula* (2300 m), *Eusidama* (2400 m), *Metarhabdopygus* (2800 m), *Sesostrellus* (2900 m), *Spinixestus* (2400 m), and *Hindreus* (3300 m). Endemics at or above 3500 m can be found among the members of the genera *Metabiantes, Monobiantes, Proconomma, Aberdereca, Bambereca, Ereca, Erecula, Eusidama, Hypoxestus, Metarhabdopygus, Metaereca, Randilea, Sesostrellus, Simienatus, Spinixestus, Cristina, Dacnopilio, Guruia, Hindreus, Odontobunus, Rhampsinitus.*

Araneida. Much has been done in the study of Afrotropical spiders, but some of the most important publications were produced by older authors (E. Strand, A. Tullgren, R. de Lessert, H. Fage, E. Simon, L. Berland) and need revision. Newer contributions come from Benoit (1978), Berland (1914, 1920), Bosmans (1977, 1978, 1979, 1981a,b), Bosmans & Jocqué (1983), Denis (1950, 1962), Fage (1940), Lessert (1915-1926), Russel-Smith & Jocqué (1986), Jocqué (1981), Scharff (1992), and Wesolowska (1986).

When we analyze the high-altitude spiders of tropical Africa, we can see that only representatives of the suborder Mygalomorphae (Migidae, Dipluridae) live above 2200 m. Some genera are endemic to Africa (*Mallinella, Aberdaria*). The large number of African spiders in the suborder Araneomorphae fit into the general pattern of the Old World (see Introduction).

Some genera living above 2200 m are: *Lepthyphantes, Microlinyphia, Erigone, Asthenargus, Oedothorax, Meioneta, Trichopterna, Walckenaeria* (Linyphiidae) and *Heliophanus* (Salticidae).

Altitudes above 3500 m are reached by species belonging to the genera *Pelecopsis* (4930 m) and *Heliophanus*, Salticidae (4650 m), *Araeoncus* (4650 m), *Callitrichia* (4930 m), *Microcyba* (4320 m), *Oreocyba* (4300 m), *Erigone* (4200 m), *Lepthy-phantes* (4000 m), *Toschia* (3920 m), *Walckenaeria* (3820 m), *Tybaertiella* (3750 m), *Asthenargus* (3550 m), and *Mallinella*, Zodariidae (3500 m). In Africa no spiders have been found above 5000 m (on the three mountains higher than this).

The family Linyphiidae, the most numerous with 97 species and 30 of the 36 genera, is particularly well studied (Scharff 1992). This family, with *Callitrichia* and *Pelecopsis*, reaches the highest altitudes in Africa. Sixteen genera living above 3000 m belong to the Linyphiidae. Some genera of Linyphiidae have developed many species: *Ctenus* (13), *Microcyba* (12), *Pelecopsis* (12), *Callitrichia* (11), or *Lepthyphantes* (9).

The available data on the Afrotropical spiders are incomplete and unreliable; nevertheless we believe that - as the case is in other montane areas (see later) - in the Afrotropis at an altitude of 2200 m about 50% of all species of spiders belong to Linyphiidae.

Acariformes. Acaridida are not well studied. Some are known from altitudes at or near to 3500 m (family Glycyphagidae with *Glycyphagus domesticus* and family Anoetidae with *Histiostoma telatum*) (André 1945, Mahunka 1982a).

In the mountains of tropical Africa Prostigmata have been studied mainly by Evans and André. Our extensive collections from various mountains are still being studied. The data from the Afrotropical mountains mainly include the families Anystidae, Bdellidae, Erythraeidae, Trombidiidae and Microtrombidiidae. Rhagidiidae (also found in the Himalaya) were collected by us on Kilimanjaro at 3500 m, but are still under study. From the mountains of tropical Africa many genera have been recorded which are either unknown in Europe or not found in the higher zones of European mountains: *Compsothrombium, Dinothrombium, Dromeoothrombium, Eutrichothrombium* (Trombidiidae), *Camerotrombidium, Enemothrombium* (Microtrombidiidae). On the other hand families, genera and

even species (*Anystis baccarum* L. on Kilimanjaro) are shared with European oreal. The highest record for prostigmatid mites in tropical Africa is at 4200 m (Trombidiidae on Mt Elgon).

Oribatida have been studied by Evans, Balogh, Mahunka, Stary and others. In the Afrotropical oreal at least 19 families have been recorded (see appendix).

The oribatids, reaching or surpassing 3500 m in the Afrotropics, belong to the genera *Liochthonius* (3890 m), *Tectocepheus* (3890 m), *Microtegeus* (4285 m), *Dampfiella* (3890 m), *Amerioppia* (3820 m), *Quadroppia* (3820 m), *Oppia* (4285 m), *Scutovertex* (4438 m), *Incabates?* (3820 m), *Nannerlia* (3890 m), *Zygoribatula* (3810 m), *Scheloribates* (4590 m), *Africoribates* (4590 m), *Ghilarovizetes* (3900 m), and *Oribates* (3810 m). *Scheloribates laevigatus* C.L. Koch was recorded (with questionmark) from Kilimanjaro up to 4590 m. This is also the maximum altitude at which oribatids (and Acari in general) in Africa have been recorded.

Parasitiformes. The suborder Gamasida is not well known, especially in the Afrotropical oreal. Of Ixodida, Neumann (1910) and other authors have recorded the genera *Ixodes* and *Rhipicephalus* in the high mountains of tropical Africa (up to 3500 m on Mt Meru).

Symphyla. This group was studied by Ribaut, Silvestri and Scheller. In equatorial Africa seven species are known to live above 2200 m. The genus *Hanseniella* is dominant in the tropical mountains and is practically the only genus of Symphyla known to live above 3000 m. According to Silvestri (1907) and Scheller (1954), *Hanseniella* lives on Ruwenzori up to 4500 m. *Symphylella vulgaris* is found in Africa (above 2200 m) and in Europe.

Chilopoda. Centipedes were studied mainly by Attems and Ribaut. Scolopendromorpha reach 3500 m (*Cryptops* on Mt Meru and Mt Elgon) and 4000 m (*Scolopendra afra* Mein. on Mt Elgon). Lithobiomorpha are very scarce on the mountains of Central and East Africa. Instead of Lithobiidae we find Henicopidae. The genus *Lamyctes* goes much higher (up to 4200 m on Ruwenzori) than the European Lithobiomorpha. Geophilomorpha: In East Africa one species of *Schendylurus* (Schendyluridae) occurs up to 2210 m. This is a family which East Africa does not share with the other mountains of the Old World, but with South America. Species of *Alloschizotaenia*, Geophilidae, live up to 2800 m, those of *Mecistocephalus*, Mecistocephalidae, reach at least 3900 m (on Nyiragongo).

Diplopoda. This class was studied especially by Attems (1909, 1939), Brölemann (1920), and Mauriès & Heymer (1996). At least four orders live in tropical Africa above 2200 m: Polyxenida, Stemmiulida, Spirostreptida and Polydesmida. The tiny Polyxenida are represented in tropical Africa by one family (Polyxenidae) up to 2740 m (Mt Elgon). The family Stemmiulidae (Stemmiulida) reach 3500 m on Mt Meru, the Odontopygidae (Spirostreptida) reach 3000 m on Kilimanjaro. Polydesmida are represented in the Afromontane environment by the families Fuhrmannodesmidae (*Elgonicola jeanneli* Attems up to 3500 m on Mt Elgon, and *Sphaeroparia petarberoni* Mauriès et Heymer up to 4200 m on Ruwenzori) and Oxydesmidae (up to 3000 m on Kilimanjaro).

Comparison between the Isopoda, Arachnida and Myriapoda of the Palaearctic and the Palaeotropical mountain systems

IAM in the Atlas and the mountains of tropical Africa

None of the many Afromontane species, genera and even families of IAM is known to live in the oreal of the Atlas (Alderweireldt & Jocqué 1992, Denis 1961, 1967, Lépiney 1939, Verhoeff 1937, 1938 a,b). The montane IAM of the Atlas are of clearly Palaearctic type, which agree with the findings of other groups of animals and plants.

IAM in the European oreal and in the mountains of tropical Africa

Isopoda. If we compare the high mountain Isopods of Europe and of tropical Africa, we can see that between the 24 species in Europe and the 66 species in tropical Africa living higher than 2200 m there are no species in common. Of the 10 genera in Europe and the 35 in tropical Africa there are no genera in common. At the family level there is some overlap at this altitude: just two of the seven families living in Europe and the five in Africa are shared by the two continents (Porcellionidae and Oniscidae).

In Europe the highest altitude is reached by representatives of the genus *Porcellio* (3300 m in Sierra Nevada). The family Porcellionidae is not very numerous in the montane Afrotropis. The highest occurring species belong to *Uramba* at 2500 m and *Thermocellio* at 2200 m – in the zone of tropical montane forests. The numerous Eubelidae (up to 4600 m), Philosciidae (up to 3700 m) and Armadillidae (up to 3100 m), so typical of the Afrotropis, are absent from the high mountains of Europe; Eubelidae do not live in Europe at all.

Table 7: Comparison of typical families of Isopoda between European and Afrotropical oreals

European oreal	**Afrotropical oreal**
Porcellionidae	Porcellionidae
Oniscidae	Oniscidae
Trichoniscidae	Philosciidae
Mesoniscidae	Eubelidae
Buddelundiellidae	Armadillidae
Trachelipodidae	
Armadillidiidae	

Pseudoscorpionida. Only 12 species of Pseudoscorpionida, belonging to 3 genera (*Chthonius, Neobisium*[2] and *Allochernes*) are known from the European oreal

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[2]) One exception is the European species *Neobisium muscorum* (= *N. carcinoides*), recorded by Mahnert (1981) on the basis of tritonymphs from Aberdare in Kenya (3203 m), the first representative of *Neobisium* in Africa south of the Sahara. In the extensive collections of Mahnert from African mountains, as well as in the collections of the older specialists (publications of M. Beier), we could not find *Neobisium*, so the authenticity and the autochthonous character of this species is doubtful. This is why we do not consider this record in our zoogeographical analysis.

(without the Caucasus). These genera are absent from the mountains of equatorial Africa.

In the mountains of equatorial Africa all three European families are present, but also eight families more, three of which (Lechytiidae, Tridenchthoniidae and Ideoroncidae) do not live in Europe at all. Except the doubtful *Neobisium*, none of the remaining Afrotropical genera occurs in the European oreal. Only two of the genera (*Withius* and *Apocheiridium*) live on the European continent at all.

Table 8: Comparison of families and genera of Pseudoscorpionida in the oreals of Europe and the Afrotropis

Europe	**Afrotropis**
Chthoniidae	**Chthoniidae**
Chthonius - up to 3030 m	Tyrannochthonius - up to 2900 m
Neobisiidae	**Neobisiidae**
	Microbisium - up to 3300 m
Neobisium - up to 3600 m	(Neobisium - up to 3203 m)
Chernetidae	**Chernetidae**
Allochernes - up to 2600 m	Caffrowithius - up to 3300 m
	Nudochernes - up to 3700 m
	Lechytiidae
	Lechytia - up to 2900 m
	Tridenchthoniidae
	Compsaditha - up to 2300 m
	Verrucadithella - up to 3200 m
	Geogarypidae
	Afrogarypus - up to 2900 m
	Ideoroncidae
	Negroroncus - up to 2250 m
	Cheiridiidae
	Apocheiridium - up to 2300 m
	Cryptocheiridium - up to 3200 m
	Atemnidae
	Cyclatemnus - up to 3000 m
	Micratemnus - up to 2200 m
	Paratemnoides - up to 3050 m
	Titanatemnus - up to 4100 m
	Cheliferidae
	Hansenius - up to 2250 m
	Microchelifer - up to 2700 m
	Withiidae
	Ectromachernes - up to 3000 m
	Stenowithius - up to 2180 m
	Trichotowithius - up to 3000 m
	Withius - up to 3500

Opilionida. All high-mountain harvestmen in Europe belong to five families of the Palpatores (28 species above 2200 m). In the mountains of equatorial Africa above 2200 m, 66 species of Opilionida (46 Laniatores and 20 Palpatores) have been recorded. In Europe only two species live above 3000 m (both in the genus *Mitopus*), in equatorial Africa 34.

Araneida. Out of the 18 genera of spiders, known in the Afrotropical oreal above 3000 m, more than half are also represented in similar habitats in Europe (*Lepthyphantes, Microlinyphia, Erigone, Asthenargus, Araeoncus, Ceratinopsis, Pelecopsis, Meioneta, Walckenaeria, Heliophanus*). From eight genera known above 4000 m, five (*Lepthyphantes, Erigone, Araeoncus, Pelecopsis, Heliophanus*) are also inhabitants of the higher parts of European mountains.

Acariformes. The mites of the suborder Acaridida are not adequately studied in both areas. The genus *Histiostoma* (Anoetidae) is present both in European and Afrotropical mountains. In Europe and especially in the Alps Prostigmata are better known (over 2200 m with at least 20 families, 35 genera and more than 100 species, excluding the strict parasites such as Myobiidae, Listrophoroidea, etc.). This group is less well known in the Afrotropical oreal. Families, genera and even species (*Anystis baccarum* L.) are shared with the European oreal. The highest record for prostigmatid mites in Europe is at 3774 m (Bdellidae in the Alps), in tropical Africa at 4200 m (Trombidiidae on Mt Elgon). In Europe, many genera recorded on the mountains of tropical Africa are either unknown or are found only in the lower regions.

We have already considerable information on the representatives of Oribatida in the oreals of Europe and tropical Africa. Most of the families in the Afrotropical oreal live also in the European mountains. Many genera are also shared (*Liochthonius, Brachychthonius, Heminothrus, Nothrus, Nanhermannia, Scheloribates, Ceratozetes, Galumna, Tectocepheus, Suctobelba, Oppia, Quadropia, Rhysotritia*). *Scheloribates laevigatus* C.L. Koch occurs in the Alps up to 2700 m.

Parasitiformes. The suborder Gamasida is not well known in both regions. The other suborder, Ixodida, is represented in both with different species of the genus *Ixodes*.

Symphyla. Both families of Symphyla live in both regions. In Europe, seven species are known above 2200 m, in equatorial Africa also seven. The two regions even share one species - *Symphylella vulgaris*. All other Afromontane Symphyla belong to the genus *Hanseniella*, represented also in Europe but only by a small number of lowland species. In the Afrotropical oreal the genera *Geophilella* and *Scutigerella* have not been found, but they are known from some European mountains.

Chilopoda. In Europe, Geophilomorpha reach 2900 m (*Geophilus*) and Scolopendromorpha 2700 m (*Scolopendra*, both in the Sierra Nevada). Scutigeromorpha do not live in the higher parts of the European mountains. Lithobiomorpha (family Lithobiidae) is represented by the genera *Eupolybothrus* (up to 2500 m) and *Lithobius* (up to 2914 m), in total by at least 20 species.

In the Afrotropical oreal Geophilomorpha reach at least 3900 m (*Mecistocephalus* on Nyiragongo), and Scolopendromorpha 3500 m (*Cryptops, Lamnonyx* on Mt Meru and Mt Elgon). Instead of Lithobiidae (Lithobiomorpha) we find

Henicopidae in the Afrotropical oreal. The genus *Lamyctes* occurs much higher than the European Lithobiomorpha (4000 m).

Diplopoda. Of the 13 orders of Diplopoda living in high-altitude environments of the Old World, six live in the European and four in the Afrotropical oreal (table 9).

Table 9: Comparison of the occurrence of orders (and families) of Diplopoda in the oreals of Europe and Africa

European oreal	African oreal
Polyxenida (Polyxenidae)	Polyxenida (Polyxenidae)
Glomerida	–
Craspedosomatida	–
Julida	–
Chordeumatida	–
–	Stemmiulida
–	Spirostreptida
Polydesmida (Polydesmidae)	Polydesmida (Fuhrmannodesmidae, Paradoxosomatidae)

We can see that at the level of orders there are considerable differences between the two areas. Only two orders - the Polyxenida and Polydesmida - and one family - Polyxenidae - are shared.

IAM in the Himalaya and mountains of tropical Africa

The Himalaya is much higher and is situated farther north than the mountains of tropical Africa. Nevertheless, some IAM reach higher altitudes in the Himalaya (over 5000 and even 6000 m) than in the African oreal. The Himalaya has a dual zoogeographical character: it belongs partly to the Palaeotropical realm, of which the mountains of tropical Africa are also a part, but their northern slopes form the southern limit of the Holarctic.

Table 10: Comparison of the families of Isopoda from the Himalaya and Afrotropical mountains

Himalaya above 2200 m	Afrotropics above 2200 m
Philosciidae	Philosciidae
Armadillidae	Armadillidae
Porcellionidae	Porcellionidae
Oniscidae	Oniscidae
Trachelipodidae	Eubelidae

Isopoda. Only nine species of terrestrial Isopoda, belonging to five families, have been recorded so far from the Himalaya from altitudes over 2200 m. In the Afrotropical oreal their number is much higher: 66 species in 5 families. Of these five families four are shared by the two regions. The family Eubelidae in Africa is replaced by the Trachelipodidae in the Himalaya (see table 10). None of the five genera of woodlice in the high Himalaya and the 35 genera in the mountains of tropical Africa occurs in both regions.

Pseudoscorpionida. In the Himalaya above 2200 m, 30 species of pseudoscorpions have been found, 17 species above 3000 m, 7 above 3500 m, and 2 above 4000 m. The species living higher than 2200 m belong to 20 genera and 12 families. In the mountains of tropical Africa above 2200 m, 56 species in 25 genera and 13 families are known (without the doubtful finding of *Neobisium* - see footnote p.166). There is a considerable similarity in the number of taxa of all ranks. In the Himalaya, the family Hyidae (the highest) is additional, in the Afrotropical mountains the Ideoroncidae. Both mountain systems share 10 families and 5 genera above 2200 m: *Tyrannochthonius, Lechytia, Apocheiridium, Calocheiridius* and *Withius*. There are no species in common. In the Himalaya, pseudoscorpions have been recorded up to 5000 m (*Stenohya*), and in the Afrotropical oreal up to 4100 m (*Titanatemnus*).

Table 11: Decrease in number of species of Pseudoscorpionida with altitude in the Himalaya and the mountains of the Afrotropics

	Himalaya	**Afrotropics**
> 2200 m	30	56
> 3000 m	17	22
> 3500 m	7	6
> 4000 m	2	1

Opilionida. As already said, the opilionid fauna of the Himalaya reflects the dual zoogeographic character of this mountain system. In the higher parts of the Himalaya both suborders Laniatores and Palpatores (the last suborder being predominant) are present. In the Himalayan opilionids above 2200 m (including four species found up to 2150 m) the ratio of the genera of Laniatores:Palpatores is 9:21, and of species 29:58 (in both cases approximately 1:2). For comparison: in the mountains of Central and equatorial East Africa above 2200 m, the ratio of genera is 11:5, and of species 46:20. The ratio is just the opposite.

In the Afrotropical oreal, 26 opilionid species (out of 66) have been found above 3500 m, 12 above 4000 m and only two (*Hypoxestus accentuatus*, Assamiidae, and *Rhampsinitus bettoni*, Phalangiidae) above 4500 m. In the Himalaya above 2200 m, at least 87 opilionid species are known, 45 above 3000 m, 15 above 3500 m, seven above 4000 m and two above 4500 m (*Himalphalangium palpale*, Phalangiidae, and *Sabacon* sp., Sabaconidae, which occurs even above 5000 m). In the mountains of tropical Africa above 2200 m, three families of Opilionida (Assamiidae, Biantidae, Phalangiidae) are found, and seven in the Himalaya. All high-altitude

African families are also present in the high Himalaya, but four additional families occur (Oncopodidae, Sabaconidae, Phalangodidae, Sclerosomatidae). In the Afrotropical oreal at least 20 genera have been recorded, 11 (55%) of Assamiidae and six (30%) of Phalangiidae, more typical of the Holarctic realm. In the high Himalaya, Martens, Suzuki and other specialists have found representatives of at least 30 genera above 2200 m, 6 (20%) of Assamiidae and 18 (60%) of Phalangiidae. There are no genera in common between the two mountain systems.

Araneida. There are some differences between the Himalayan and the Afrotropical oreals in families and even in suborders. In the Afrotropical oreal (up to 2500 m) representatives of Mygalomorphae occur that are absent in the Himalaya above 2200 m. Here, only species of the suborder Araneomorphae are known (Anapidae, Tetrablemmidae, Sicariidae, Salticidae, etc). In both areas the family Linyphiidae dominates. Both systems also share some genera belonging to this family *(Lepthyphantes, Erigone, Asthenargus, Walckenaeria, Oedothorax)* which also occur in the European oreal. Some genera have developed many species in the high Himalaya: *Lepthyphantes* (19), *Yaginumaella* (14), *Xysticus* (9), and *Pardosa* (8). But there are no species in common between the Himalaya and Central Africa.

We found that four families of spiders in the Old World form the highest associations, inhabiting the regions above 5000 m: Lycosidae, Salticidae, Linyphiidae and Gnaphosidae. In the Himalaya above 3500 m, we find 18 genera, the highest at 6100 m. In Africa no spiders have been found above 5000 m (in the three mountains overpassing this altitude).

Acariformes. No information exists on Himalayan Trombidiidae, but the other recorded Prostigmata in both areas are completely different. Rhagidiidae have been collected by us on Kilimanjaro at 3500 m, but are still under study and it is not possible to compare them with the five species of five genera found in the Himalaya at 3900 m (Zacharda & Daniel 1987).

Oribatida. Almost all families and genera, recorded from the high Himalaya (above 2200 m) are also known from the higher mountains of tropical Africa. In the Himalaya a few species have been recorded from this altitude, mostly by Aoki, Piffl, Sheals, Travé, Mahunka and other authors. Janetschek (1990) mentions many species - identified only up to the genus, found during his expedition up to 5800 m - that are some of the highest in the world. The genera, however, are widespread and are present also in the European mountains (*Liochthonius, Hermannia, Belba, Oribatula, Scheloribates, Trichoribates, Oribatella, Ceratoppia, Tectocepheus,* and *Suctobelba*).

Parasitiformes. The suborder Gamasida is not well known in both regions. The suborder Ixodida reaches 5488 m in the Himalaya (*Ixodes berlesei* Birula, the highest locality for Ixodida and Parasitiformes in the world). At least six species of the genus *Ixodes* in the Himalaya live above 3600 m. In the Himalaya *Haemaphysalis aponommoides* Warburton also occurs up to 4880 m, as does the endemic genus *Anomalohimalaya*. In tropical Africa *Ixodes* (with different species) and *Rhipicephalus* reach considerable altitudes (up to 3500 m).

Symphyla. The two families in the class Symphyla and the genus *Hanseniella* are shared by the Himalaya and the mountains of equatorial Africa. In the high Himalaya only 1-2 species of Symphyla have been recorded (up to 4900 m), as opposed to seven species in the higher parts of equatorial Africa (up to 4500 m).

Chilopoda.

Scutigeromorpha. Not yet identified scutigeromorphs have been collected by us in Nepal up to 4250 m. There is no information concerning this order in the high-altitude tropical Africa.

Lithobiomorpha. The centipedes of this order are widespread in the Himalaya and known up to 5545 m (*Lithobius hirsutipes khumbensis*). In these mountains above 2200 m at least ten species have been found, all belonging to Lithobiidae (*Lithobius* with two species). The family Lithobiidae and genus *Lithobius* are known from the High Atlas, but are absent from the Africotropical mountains. There we find (up to 4000 m on Mt Kenya) two species of the genus *Lamyctes* (family Henicopidae), which is unknown in the high Himalaya. The difference between the two oreals in the Lithobiomorpha is at the family level.

Geophilomorpha. As in the Lithobiomorpha, the difference here also lies at the family level: in the Himalaya at least two species of *Tygarrup* (Mecistocephalidae) occur, in East Africa one species of *Schendylurus* (Schendyluridae).

Scolopendromorpha. Several Scolopendromorpha (Scolopendridae) live in the high Himalaya above 2200 m (*Cryptops* up to 4500 m, *Otostigmus* up to 3000 m, *Ethmostigmus* up to 2700 m and *Rhysida* up to 3400 m). That means that only *Crytops* is shared by the oreals of the Himalaya and Central Africa.

Diplopoda. In the last two decades the Diplopoda fauna in the Himalaya has become one of the best known in the world, mainly because of the intensive field work of J. Martens and the research of Golovatch, Mauriès, Enghoff, Shear and

Table 12: Comparison of the orders and families of Diplopoda between the Himalayan and Afritropical oreal

	Himalaya	Africa
Order Spirostreptida		
	Harpagophoridae	Odontopygidae
Order Polydesmida		
	Fuhrmannodesmidae	Fuhrmannodesmidae
	Paradoxosomatidae	Paradoxosomatidae
	Polydesmidae	Oxydesmidae
	Opisotretidae	
Order Polyxenida		
	Polyxenidae	Polyxenidae

other specialists. The two regions share three orders: Polyxenida, Spirostreptida and Polydesmida, but only three families (Polyxenidae, Fuhrmannodesmidae, and Paradoxosomatidae) and not a single genus (table 12).

At least five genera in the family Fuhrmannodesmidae live in the Himalaya above 2200 m, while on Ruwenzori in the Afrotropical oreal the genus *Sphaeroparia* reaches 4200 m (*S. petarberoni* Mauriès et Heymer).

IAM in the mountains of tropical Africa and Central Asia

The mountains of Central Asia (Afghanistan, Pakistan, Hindu Kush, Karakorum, Pamir, Tien Shan, Kunlun, and Tibet - from the border between Iran and Afghanistan to 120° E) are situated more to the north and are higher than the mountains of tropical Africa (which do not reach 6000 m). The two systems have a different vertical zonation, origin, climate and vegetation. They also belong to different zoogeographical regions and even realms, and their faunas have been isolated from each other at least since the Quaternary.

Isopoda. From the mountains of Central Asia only ten species of Isopoda have been recorded above 2200 m, belonging to three families. The two areas in question share two families: Porcellionidae and Armadillidae. In the mountains of tropical Africa the family Eubelidae dominates, but does not occur in Central Asia. The Central Asian mountains share the family Trachelipodidae with Europe and the Himalaya. None of the four genera in the Central Asian oreal and the 35 genera in Afrotropical mountains is common to both. The arid mountains of Central Asia are characterized by genera like *Protracheoniscus* and *Desertoniscus* (as high as 4725 m), the Afrotropical oreal by the more hygrophilous representatives of Eubelidae, Philosciidae, etc. (up to 4600 m).

Pseudoscorpionida. At least 12 species in eight families have been recorded from Central Asia above 2200 m, including 11 above 3000 m and four above 3500 m. From the oreal of tropical Africa over 2200 m, 28 species of Pseudoscorpionida have been recorded, belonging to 21 genera and 11 families (up to 4100 m). The highest Central Asian records within the Neobisiidae are of *Bisetocreagris kaznakovi* (Red.) (Tibet 4810 m), and within the Cheliferidae *Dactylochelifer brachialis* Beier (Karakorum 4200 m), *Gobichelifer chelanops* (Red.) (Karakorum 3650 m) and *"Chelifer" baltistanus* di Cap. (Karakorum 3950 m). All families of pseudoscorpions from montane Central Asia live also in the high mountains of tropical Africa; of the African families, the Lechytiidae, Tridenchthoniidae and Withiidae are not represented in Central Asia above 2200 m. There are no genera in common between the two areas.

Opilionida. Few species of Opilionida are known to live in the vast arid mountains of Central Asia. This fauna is much poorer than the Himalayan or the Afrotropical.

They all belong to the suborder Palpatores and mainly to the family Phalangiidae s.lat. (one species belongs to Sclerosomatidae). The highest species is *Homolophus nordenskioeldi*, living at up to 5600 m (a world record for Opilionida). Representatives of the genera *Diabunus, Egaenus, Opilio*(?) and *Phalangium*(?) live above 3500 m. These data are rather fragmentary and after research in some remote corners of Tibet with Indomalayan influence the picture is likely to change.

For the moment there are no Opilionid genera in common between the Afrotropical and the Central Asian oreals.

Araneida. In Central Asia above 2200 m more than 180 species of spider have been found, belonging to 18 families, but only four families contain at least 148 of these species: Linyphiidae (87), Gnaphosidae (22), Salticidae (19) and Lycosidae (20). The 88 species of the Linyphiidae belong to 36 genera (in the Afrotropical oreal there are 97 species in 30 genera). The figures are quite close. We have already pointed to the amazing coincidence in the percentage of high-altitude Linyphiidae versus the other spiders in the high Alps (51,2%) and in the mountains of Central Asia (51,8%). Nine genera (probably more) are common to the two areas above 2200 m: *Lepthyphantes, Microlinyphia, Erigone, Asthenargus, Oedothorax, Meioneta, Trichopterna, Walckenaeria* (Linyphiidae) and *Heliophanus* (Salticidae).

We mentioned already that in tropical Africa more than half of the 18 genera of spiders living above 3000 m are also represented in the oreal of Europe. Of the genera living above 3500 m (38 in Central Asia, 14 in the Afrotropical oreal) four are shared, of those above 4000 m (8 in Africa, 26 in Central Asia) three are shared, and above 4500 m only *Erigone* and *Heliophanus* live in both areas. The four shared genera above 3500 m are:

Heliophanus (Salticidae): 4600 m (Central Asia), 4650 m (tropical Africa)

Erigone (Linyphiidae): 4950 m (Central Asia), 4200 m (tropical Africa)

Lepthyphantes (Linyphiidae): 4250 m (Central Asia), 4000 m (tropical Africa)

Pardosa (Lycosidae): 5170 m (Central Asia), 3700 m (tropical Africa).

Acariformes. The suborder Oribatida deserves special attention, as there is reliable information about these important mites in both regions. There are a number of common families: of the 20 families in the Afrotropical oreal and the 35 in Central Asia, 12 are shared, but many others may also be in common since they occur in one of the regions but have so far been recorded only at lower altitudes. There are also some genera in common *(Liochthonius, Heminothrus, Nanhermannia, Tectocepheus, Amerioppia, Quadroppia, Oppia, Scutovertex, Zygoribatula, Scheloribates*) but no species.

In the mountains of Central Asia an altitude of 3500 m is reached by the genera *Hypochthonius, Liochthonius, Heminothrus, Nothrus, Scutovertex, Zygoribatula, Gerloubia, Scheloribates, Ceratozetella, Diapterobates, Punctoribates, Eupelops, Unduloribates, Suctobelbella,* and *Novosuctobelba*, that of 5000 m by *Tectocepheus, Oribotritia, Oribatella,* and Sphaerobates.

In this (clearly incomplete) list of 19 Central Asian montane genera we find five living in both oreals: *Liochthonius, Tectocepheus, Scutovertex, Zygoribatula,* and *Scheloribates.* The limit of 3500 m for many of the Central Asian genera is an artificial one, because this was the upper limit of the research carried out by Maria Hammer in the Hindu Kush. In the Himalaya, oribatids have been recorded up to 6100 m, which may be true for Central Asia too. For the other Acari, *Ixodes* is the shared genus (up to 3600 m in Tien Shan, up to 3500 m on Mt Meru).

Symphyla. So far no specimens of this class have been recorded from Central Asia.

Chilopoda.

Lithobiomorpha. As in Europe and the Himalaya, in Central Asia representatives of the genus *Lithobius* (Lithobiidae up to 4300 m) dominate, and they do not occur in the Afrotropical oreal. In Tajikistan we found another genus of the family Lithobiidae: *Hessebius*, as high as 4500 m. In tropical Africa the litho-biomorphs are represented by the family Henicopidae (*Lamyctes* up to 3500 m).

In the Scolopendromorpha one genus is shared by the two oreals - *Scolopendra* (in Central Asia up to 2700 m, in tropical Africa up to 2710 m). This is the only genus of Scolopendromorpha collected in Central Asia so far.

The order Geophilomorpha in Central Asia is represented by two families (Geophilidae up to 2820 m in Afghanistan and Mecistocephalidae up to 3500 m in Tibet). They live also in the Afrotropical oreal, but the genera are different.

Scutigeromorpha. Verhoeff has described one species of the genus *Thereuopoda* from Central Asia (3100 m); they are unknown in the oreal of tropical Africa.

Diplopoda. Central Asia, and especially its high and arid parts, are among the poorest regions for Diplopoda in the world. According to Golovatch, in the deserts of Central Asia huge regions exist where this forest-dwellers are absent. The few genera we know of are close to the Himalayan fauna and have nothing in common with the rich diplopod fauna living in the Central African mountains.

Discussion

The comparison between the non-insect arthropod faunas of the montane Afrotropics and the oreals of Eurasia reveals many agreements but more differences. If we exclude the case of *Neobisium carcinoides* (see footnote p. 166), there are no shared species. Table 13 presents what we see in the genera.

Obviously the mutuality depends largely on the mobility of the animals. In groups with low mobility (Isopoda, Opilionida, Diplopoda) there are no common genera. Some others (Araneida, Acariformes, Parasitiformes) are more widespread. In the case of Araneida the higher mobility may be caused by balooning, in the parasitiform mites the mobility of the hosts is obviously the reason for their extension.

But we know many examples which do not fit in this scheme. According to Scharff (1992), 14 linyphiid spiders (Araneida) are endemic to the Afroalpine region. He quotes: "The high degree of endemism among forest linyphiid species on nearby mountains in eastern Tanzania does not support a theory of common or

Table 13: Number of genera in different taxa in the montane Afrotropis (above 3500 m) and those shared with in the corresponding altitudes of Eurasia

Class or order	no. in the Afrotropis	shared genera in Eurasia
Isopoda	10	0
Scorpionida	1	0
Pseudoscorpionida	4	2
Opilionida	9	0
Araneida	18	13
Acariformes	21	18
Parasitiformes	4	4
Symphyla	1	1
Chilopoda	5	2
Diplopoda	3	0

occasional contact between the faunas as a result of balooning". A mite of the family Bdellidae (Acariformes, Prostigmata) is not more mobile than a spider, but we can see that *Bdella, Erythraeus* and other Prostigmata can be found in all or most continents. A *Pardosa* spider (Araneida, Lycosidae) is not more mobile than any of the Opilionida, but the harvestmen on African mountains are largely endemic to the continent whereas those lycosids are widespread. Most genera of Oribatida (Acariformes) are also widespread although they have low mobility. These patterns obviously depend on other factors, such as age of the group, ecological plasticity, type of speciation, etc.

The distribution of some families, e.g. Eubelidae (Isopoda), Assamiidae and Biantidae (Opilionida), is palaeotropical or pantropical. Their genera, however, are entirely Afrotropical and have evolved in Africa. Very few of them are confined to the montane regions.

Fage (1940) noted that the separate high mountain massifs in tropical Africa (Kilimanjaro, Mt Kenya, Mt Elgon, Ruwenzori and others), rising like islands amidst the dry and hot savanna, share many species of spiders. It is obvious that their establishment must have taken place under quite different climatic conditions, when the montane environment was more widespread. An active exchange at present is impossible.

According to Scharff (1992) the idea of Fage (1940) is not verified by the actual data: "It is a general trend that the different mountains harbour different linyphiid species". In the opilionids, however, we see that many of them live on two or more mountain massifs, with the reservation that until now only some of the many high mountains have been sufficiently investigated.

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Appendix

Isopoda, Arachnida and Myriapoda known to live in the Afrotropical oreal above 3500 m (in brackets the main authors for those groups)

Isopoda (Barnard 1940, Budde-Lund 1910, Paulian de Félice 1941, 1945a,b, Ferrara & Taiti 1984, Taiti & Ferrara 1980, Nobili 1906, Scott 1958, Schmölzer 1974)

Fam. Eubelidae
Aethiopopactes chenzemae Ferrara et Taiti - 4600 m, Kilimanjaro
Benechinus armatus Budde-Lund - 4600 m, Mt Meru
Mesarmadillo chappuisi Paulian de Félice - 4000 m, Mt Elgon
M. arambourgi Paulian de Félice - 4000 m Mt Elgon
Hiallelgon jeanneli Paulian de Félice - 4000 m on Mt Elgon
"Periscyphis" montanus Schmölzer - 3800 m, Mt Kenya
Hiallum richardsoni Paulian de Félice - 3500 m, Mt Elgon
Periscyphis ruficauda Budde-Lund - 3500 m, Mt Kenya
Eubelum tachyorictidis Paulian de Félice - 3500 m, Mt Elgon
Microcercus sp. - 3455 m, Ethiopia

Fam. Philosciidae
Afrophiloscia uncinata Ferrara - 3700 m, Kilimanjaro

Fam. Porcellionidae
"Porcellio" spatulata Barnard - 3600 m, Ethiopia

Fam. Armadillidae
"Synarmadillo" marmoratus Budde-Lund - 3500 m, Mt Meru

Arachnida

Scorpionida (Tullgren 1910)

Fam. Buthidae
Uroplectes fischeri Tullgren - 3500 m, Mt Meru

Pseudoscorpionida (Beier 1944, 1951, 1955, 1959, 1962, Vachon 1945, Mahnert 1982a,b, 1983, 1985, 1988)

Fam. Olpiidae
Calocheiridius crassifemoratus Beier - 3650 m, Mt Elgon

Fam. Atemnidae
Titanatemnus palmquisti (Tullgren) - 4100 m, Kilimanjaro

Fam. Chernetidae
Nudochernes crassus Beier - 3700 m, Mt Elgon
N. montanus Beier - 3500 m, Mt Elgon
N. robustus Beier - 3500 m, Mt Elgon

Fam. Withiidae
Withius somalicus Beier - 3500 m, Mt Elgon

Opilionida (Sörensen 1910, Goodnight & Goodnight 1959, Roewer 1913, 1941, 1952, 1956, Lawrence 1962, Kauri 1985)

Laniatores

Fam. Assamiidae
Metaereca abnormis Roewer - 4000 m, Ruwenzori
Hypoxestus accentuatus Sör. - 4600 m, Kilimanjaro
H. holmi Goodnight et Goodnight - 4200 m, East Africa
Hypoxestus mesoleucus Sör. - 3500 m, Kilimanjaro
H. patellaris Sör. - 4000 m, Ruwenzori

Ereca undulata Sör. - 4025 m, Kilimanjaro
E. simulator Sör. - 4000 m, Kilimanjaro
E. maculata Roewer - 3975 m, Kilimanjaro
E. lata Sör. - 3500 m, Kilimanjaro
E. affinis Sör. - 3500 m, Kilimanjaro
E. modesta Sör. - 3500 m, Kilimanjaro
Randilea scabricula Roewer - 3630 m, Mt Elgon
Simienatus scotti Roewer - 3505 m, Semien, Ethiopia

Fam. Biantidae
Metabiantes punctatus Sör. - 4000 m, Klimanjaro
M. trifasciatus Roewer - 3600 m, Mt Meru
M. convexus Roewer - 3500 m, Ruwenzori

Palpatores

Fam. Phalangiidae
Odontobunus africanus Roewer - 3770 m, Kilimanjaro
O. armatus (Sör.) - 4000 m, Kilimanjaro
Rhampsinitus bettoni Pocock - 4600 m, Kilimanjaro
Rh. discolor Karsch - 3870 m, Ruwenzori
Rh. salti Roewer - 3800 m, Kilimanjaro
Rh. soerenseni Starega (= *Rh. pictus* Sör.) - 3500 m, Mt Meru
Rh. (?) mesomelas Sör. - 4000 m, Kilimanjaro
Dacnopilio scopulatus Lawrence - 3600 m, Mt Meru
Guruia africana Karsch - 4000 m, Kilimanjaro
G. frigescens Loman - 4000 m, East Africa
Cristina pachylomera Simon - 3870 m, Ruwenzori; 3658 m, Semien

Araneida (Benoit 1978, Berland 1914, 1920, Bosmans 1977, 1978, 1979, 1981a,b, Bosmans & Jocqué 1983, Denis 1950, 1962, Fage 1940, Holm 1962, Jocqué 1981, Lessert 1915-1926, Russel-Smith & Jocqué 1986, Scharff 1992, Tullgren 1910, Wesolowska 1986)

Fam. Zodariidae
Mallinella vittiventris Strand - 3500 m, Karisimbi

Fam. Linyphiidae
Araeoncus picturatus Holm - 4650 m, Kilimanjaro
A. subniger Holm - 4400 m, Mt Kenya
A. impolitus Holm - 3900 m, Aberdare
Asthenargus expallidus Holm - 3550 m, Aberdare
A. inermis Simon et Fage - 3480 m, Mt Kenya
A. marginatus Holm - 3450 m, Ruwenzori
Callitrichia ruwenzoriensis Holm - 4930 m, Ruwenzori
C. kenyae Fage - 4530 m, Mt Kenya
C. glabriceps Holm - 4200 m, Mt Elgon
C. aliena Holm - 4150 m, Mt Elgon
C. paludicola Holm - 3975 m, Kilimanjaro
C. hamifer Holm - 3800 m, Mt Elgon
C. monticola Tullgren - 3500 m, Kilimanjaro
Ceratinopsis fako Bosmans et Jocqué - 4000 m, Fako, Cameroon
Erigone aethiopica Tullgren - 4200 m, Mt Kenya; 4000 m (Cameroon)
Lepthyphantes kilimanjaricus Tullgren - 4000 m, Kilimanjaro
L. ruwenzori Jocqué - 3800 m, Ruwenzori
Meioneta obscura Denis - 4723 m, Ruwenzori
Microcyba erecta Holm - 4300 m, Ruwenzori
M. hamata Holm - 4300 Mt Elgon
M. annulata Holm - 4000 m, Mt Elgon
Microcyba brevidentata Holm - 3900 m, Kilimanjaro
M. projecta Holm - 3800 m, Ruwenzori
M. hedbergi Holm - 3730 m, Muhavura
M. falcata Holm - 3450 m, Ruwenzori

Neriene kibonotensis Tullgren - 3500 m, Kilimanjaro
Oreocyba propinqua Holm - 4300 m, Mt Elgon
O. elgonensis Fage - 4200 m, Mt Elgon
Pelecopsis ruwenzoriensis Holm - 4930 m, Ruwenzori
P. biceps Holm - 4300 m, Kilimanjaro
P. alticola Berland - 4165 m, Mt Elgon; 3850 m, Mt Kenya; 3400 m, Aberdara
P. tenuipalpis Holm - 4000 m, Ruwenzori
P. infusca Holm - 4000 m, Ruwenzori
P. senecicola Holm - 3930 m, Ruwenzori
P. pasteuri Berland - 3800 m, Kilimanjaro
P. reclinata Holm - 3760 m, Mt Elgon
P. varians Holm - 3450 m, Mt Elgon
P. flava Holm - 3450 m, Ruwenzori
Toschia telekii Holm - 4300 m, Mt Kenya
T. aberdarensis Holm - 3750 m, Aberdare
Tybaertiella kruegeri Simon - 3750 m, Karisimbi
Walckenaeria meruensis Tullgren - 3820 m, Kilimanjaro; 3280 m, Mt Meru
W. aberdarensis Holm - 3550 m, Aberdare, Mt Kenya
W. ruwenzorensis Holm - 3450 m, Ruwenzori

Fam. Hahniidae
Hahnia tabulicola Simon - 3900 m, Cameroon
H. major Benoit - 3750 m, Mt Kenya
H. sirimoni Benoit - 3750 m, Mt Kenya

Fam. Lycosidae
Pardosa alticola Alderweiteldt et Jocqué - 3700 m, Rwanda; 3650 m, Semien

Fam. Salticidae
Heliophanes crudeni Lessert - 4650 m, Kilimanjaro
H. gladiator Wesolowska - 4450 m, Mt. Kenya
H. imperator Wesolowska - 4200 m, Mt Kenya
H. kenyaensis Wesolowska - 3650 m, Mt Elgon

Acariformes (André 1936, 1938, 1945, 1957, 1965, Balogh 1966, Evans 1953, Mahunka 1982a, b, 1983a, b, 1984a, b, Trägårdh 1910)

Acaridida
Fam. Glycyphagidae
Glycyphagus domesticus (De Geer) - 3500 m, Mt Elgon

Fam. Anoetidae
Histiostoma telatum Mahunka - 3450 m, Kilimanjaro

Prostigmata

Fam. Bdellidae
Bdella piggotti Evans - 3810 m, Kilimanjaro

Fam. Anystidae
Anystis baccarum L. - 3810 m, Kilimanjaro

Fam. Erythraeidae
Charletonia areolata Trägårdh - 3810 m, Kilimanjaro

Fam. Trombidiidae
Trombidium bipectinatum Trägårdh - 3800 m, Mt Meru
T. tinctorium L. - 3800 m, Mt Meru
Trombidium meruense Trägårdh - 3800 m, Mt Meru
T. simile Trägårdh - 3800 m, Mt Meru
Dinothrombium trispilum Berlese - 4200 m, Ruwenzori
D. tarsale Berlese - 4000 m, Mt Elgon
Allothrombium pergrande Berlese - 4000 m, Kilimanjaro

Fam. Microtrombidiidae
Enemothrombium bipapillatum Berlese - 3500 m, Mt Elgon
E. carduigerum Berlese - 3500 m, Mt Elgon
E. jeannei André - 3500 m, Mt Elgon

Oribatida

Fam. Brachychthoniidae
Liochthonius tanzanicus Mahunka - 3890 m, Kilimanjaro

Fam. Haplozetidae
Protoribates shiraensis Evans - 4590 m, Kilimanjaro

Fam. Euphthiracaridae
Rhysotritia ardua (C.L. Koch) - 3800 m, Kilimanjaro

Fam. Microtegeidae
Microtegeus undulatus Berlese - 4285 m, Kilimanjaro

Fam. Ceratozetidae
Africoribates ornatus Evans - 4590 m, Kilimanjaro
Ghilarovizetes africanus Mahunka - 3900 m, Kilimanjaro

Fam. Tectocepheidae
Tectocepheus spinosus Mahunka - 3890 m, Kilimanjaro

Fam. Scutoverticidae
Scutovertex africanus Evans - 4438 m, Kilimanjaro

Fam. Dampfiellidae
Dampfiella setosa Mahunka - 3890 m, Kilimanjaro

Fam. Oppiidae
Oppia nasalis Evans - 4285 m, Kilimanjaro
O. africanus Evans - 4285 m, Kilimanjaro
Amerioppia foveolata Mahunka - 3820 m, Kilimanjaro

Fam. Quadroppiidae
Quadroppia crenata Mahunka - 3820 m, Kilimanjaro

Fam. Oribatulidae
? *Incabates longisacculus* Mahunka - 3820 m, Kilimanjaro
Nannerlia elongatissima Mahunka - 3890 m, Kilimanjaro
Zygoribatula setosa (Evans) - 3810 m, Kilimanjaro

Fam. Scheloribatidae
Scheloribates laevigatus C.L. Koch - ? 4590 m, Kilimanjaro

Fam. Oribatidae
Oribates geniculatus (L.) - 3810 m, Kilimanjaro

Parasitiformes (André 1938, Neumann 1910)

Gamasida
Fam. Macrochelidae
Macrocheles elgonensis André - 3500 m, Mt Elgon

Fam. Hypoaspididae
Hypoaspis praesternalis Willmann - Kilimanjaro

Ixodida

Fam. Ixodidae
Ixodes ugandanus djaronensis Neumann - 3500 m, Mt Meru
I. rasus Neumann - 3500 m, Mt Meru
Rhipicephalus simus C.L.Koch - 3500 m, Mt Meru

Symphyla (Ribaut 1914b, Silvestri 1907, Scheller 1954)

Fam. Scutigerellidae
Hanseniella ruwenzorii Silvestri - 4500 m, Ruwenzori, 3650 m, Mt Kenya
H. pillipes Attems - 4200 m, Ruwenzori, 4000 m, Mt Elgon
H. afromontana Scheller - 4000 m, Ruwenzori
H. producta Ribaut - 3650 m, Mt Kenya

Chilopoda (Attems 1937, 1939, Ribaut 1914a)

Geophilomorpha

Fam. Mecistocephalidae
Mecistocephalus insularis Lucas - 3900 m, Nyiragongo
M. (sub "*Lamnonyx*") *punctifrons* Newprt - 3500 m, Mt Elgon

Lithobiomorpha

Fam. Henicopidae
Lamyctes africana Poc. - 4200 m, Ruwenzori
L. fulvicornis Meinert - 4000 m, Mt Kenya

Scolopendromorpha

Fam. Scolopendridae

Scolopendra afra Mein. - 4000 m, Mt Elgon

Fam. Cryptopidae
Cryptops numidicus tropicus Attems - 3500 m, Mt Meru
C. incerta Attems - 3500 m, Mt Elgon
C. bottegoi kenyae Rib. - 3500 m, Elgon
Lamnonyx punctifrons Newport - 3500 m, Mt Elgon

Diplopoda (Attems 1909, 1939, Brölemann 1920, Mauriès & Heymer 1996)

Stemmiulida

Fam. Stemmiulidae
Stemmiulus sjostedti Attems - 3500 m, Mt Meru

Polydesmida

Fam. Fuhrmannodesmidae
Elgonicola jeanneli Attems - 3500 m, Mt Elgon
E. jeanneli microchaeta Attems - 4000 m, Mt Elgon
Sphaeroparia petarberoni Mauriès et Heymer - 4200 m, Ruwenzori
S. minuta Attems - 3500 m, Mt Meru

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